

# Public Engagement in Emerging Technologies: Issues for India

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**Abstract:** This paper examines the state of public engagement in the emerging technology of nanotechnology in India, in the context of global developments and debates on this aspect. At the same time, it presents the argument that public participation in science and technology in India is rooted in social realities far different from the Western world. As public engagement in nanotechnology is still nebulous, an important focus is the trajectory of agricultural biotechnology, which has been the subject of much controversy in the country and which could hold important lessons for nanotechnology. A basic premise of the paper is that public engagement in emerging technologies in India is heavily influenced by the exalted position of science in India, active government support for new technologies, and the non-accommodation of dissenting views and critiques in the policy set up. This, in turn, lays a strong foundation for a deficit or unidirectional mode of engagement. It examines the challenges, opportunities, and also the desirability in the Indian context in moving from a deficit to an upstream engagement model in emerging technologies.

**Keywords:** Agricultural biotechnology, emerging technologies, nanotechnology, public engagement, public participation, India

## Introduction

Social and political theorists, public interest groups, scientists and policy makers, particularly in the developed world, have widely embraced the concept of increased public engagement in Science and Technology (S&T) policy decisions. The basic premise for increased engagement is the assumption that public participation makes for better science and science-based policy. Broadly, public engagement in S&T is pursued for two different reasons (Sylvester et al. 2009). One kind of engagement is based on the belief that increased engagement would facilitate the process of public acceptance of the technology. It seeks to “pave the way” for the technology by addressing the misperceptions of the public. The role of the government in such a context is largely perceived as educational and limited to public communication. The second kind of engagement is perceived as upstream engagement where the role of the public is to aid the government in making decisions about a technology, based on reasons other than strictly scientific evidence of risks and benefits (*ibid.*). The latter kind of engagement is widely advocated as a means to address the democratic deficit in framing S&T policy and to link it better with people’s needs by including citizens’ input to technology design and assessment (Leach and Scoones 2003). Science communication or public engagement is basically carried out as per three different models: deficit, dialogue and participation

(Trench 2008). In the “deficit model,” science is conveyed by experts to audiences who are perceived to have deficient scientific awareness and understanding. In the “dialogue model,” science is communicated between scientists and their representatives and other groups, sometimes to find out how science could be more effectively disseminated, sometimes for consultation on specific applications. Finally, in the “participation model,” communication about science takes place between diverse groups on the basis that all can contribute, and that all have a stake in the outcome of deliberations and discussions (*ibid.*). Lewenstein (2003a) proposes four key models with respect to public communication of science and technology, which he refers to as the “deficit model,” “contextual model,” “lay expertise model” and “public participation model.” The deficit model, according to Lewenstein, describes a deficit of knowledge that must be filled, while the contextual model acknowledges that individuals process information according to social and psychological schemas moulded by past experiences, cultural context and personal circumstances. The lay expertise model assumes the importance of local knowledge as much as technical knowledge to solving a real world problem. Lewenstein views the public participation or engagement model as “a series of activities intended to enhance public participation and hence trust in science policy” (*ibid.*). In a similar vein, Bauer et al. (2007) trace developments in public engagement with S&T through three time-based paradigms: scientific literacy from the 1960s to mid 1980s, where the problem to be addressed is public deficit knowledge through literacy measures and education; public understanding of science from 1985 to mid 1990s, when public deficit attitudes were sought to be dealt with through knowledge-attitude and attitude change; and finally the science and society paradigm from the mid 1990s. Here, the deficits addressed are trust deficit, expert deficit and others, through participation and deliberation to “rebuild trust.”

There is consensus that a discernible shift from the “deficit” to the “upstream” model has taken place in recent S&T developments in most of the Western world, though some observers have expressed reservations on the completeness of this shift (Trench 2008, Lewenstein 2003a). According to Kurath and Gisler (2009), three technology controversies on atoms, genes and nano have been primarily responsible for turning the style of science communication from one-way information to the idea of an early and more democratic engagement of the public, with controversies in one technology field contributing to shaping the subsequent field. In their opinion, the result is that nanoscience and technology is characterized by a distinct policy shift towards earlier and more democratic involvement of the public. This kind of upstream public engagement in nanotechnology gained importance with the publication of the report of the Royal Society and the Royal Academy of Engineering on nanoscale sciences and technologies (2004) and an editorial in *Nature* (2004), with the latter strongly coming out in favour of scientists letting the public decide how government research funds are to be spent.

Another important aspect of the public engagement debate in the developed world has been the framing of the publics as laypeople versus scientists, experts and researchers. Scholars like Cambrioso and Limoges (1991) have strongly advocated that public engagement involving sensitive technologies should focus only on the actors that are knowledgeable and actually engaged in it. Marris et al. (2001), however, argue that strategies, which involve both the key stakeholders and the public, can contribute to a better understanding and a more constructive debate. According to Wynne (2001), laypeople can meaningfully engage in science and technology discussions. He argues further that the sceptical stance of the public, as in the case of agricultural biotechnology

in Europe, is not due to public ignorance of scientific information but the result of public mistrust of science, governments, and their official representatives. Following the publication of the influential report *Taking European Knowledge Society Seriously* by the European Commission in 2007, there has been a growing commitment to the opening up of S&T governance from a “closed cadre of experts” to a “plurality of voices and framing conditions” (Lovbrand et al. 2010).

It is in the context of these broad developments in public engagement with S&T that the present paper examines the state of public engagement with nanotechnology in India. At the same time, it cannot be overemphasized that public participation in S&T in India, and indeed in most of the global South, is rooted in realities far different from the developed world. The various models of public understanding, according to Lewenstein (2003a), have emerged largely in highly developed countries where people are making personal or policy choices in contexts in which essential human needs have been met and where the choices involve access to information, political or social power and respect for differing social values. This is not the case in the developing world, where public understanding of science is more about addressing fundamental barriers to scientific information:

“[T]hese barriers are not caused by ignorance or hostility, but by the core conditions of the developing world—local languages, poverty, lack of public health, lack of economic infrastructure and lack of education.” (*ibid.*).

Sahai (1999), in the context of agricultural biotechnology, argues that objections to biotechnologies in the Western world might be logical in a food surplus context, but to transfer these debates to India (where hunger deaths still occur widely) without contextualization would not only be “an act of plagiarism, but of irrelevance, uncreative in its use of rhetorics and metaphors.”

Another basic premise of this paper is that public engagement around emerging technologies in India is heavily influenced by the exalted position of science in the policy set up, with S&T not easily accessible for critical engagement, unlike in the West. This, in turn, creates a strong basis for a unidirectional or deficit mode of public engagement. This trend has been observed in other developing countries as well. For instance, Massarani (2002) argues that science communication in Brazil gives emphasis only to the positive aspects of science and does not touch upon “important points such as the real scientific process with its tortuous paths and the presence of controversies and risk aspects in science.”

As public engagement around nanotechnology in India remains opaque, an important focus is the trajectory of agricultural biotechnology, which has been the subject of much controversy in the country and which could hold important lessons for nanotechnology. The paper examines the challenges, opportunities and also the desirability in the Indian context in moving from a deficit to an upstream engagement model in emerging technologies.

## 1. Methodology

Public participation in S&T is a little studied issue in India, indeed in most of the global South. Also, state-sponsored initiatives for public engagement in S&T remain extremely limited. As a result, many of the premises and findings of the paper have been drawn from archival review of the limited number of government policies on S&T (e.g.

Science Policy Resolution 1958, Technology Policy Statement 1983, Science and Technology Policy 2003) and existing—again, limited—science and technology studies from an Indian perspective. This paper draws from the qualitative analysis of a series of focus group discussions (FGDs) and in-depth interviews on agricultural biotechnology conducted in 2008 with different publics and stakeholders in both urban and rural areas of three states of India: Punjab, Maharashtra and Assam. While both Punjab and Maharashtra allow farming with Bt Cotton—the only state-approved, commercially grown genetically engineered crop in India, Assam still does not support the production of genetically engineered organisms (GMOs).

The publics of this study include scientists, farmers, students and urban housewives. Finally, the paper also analyses the findings of a small number of surveys conducted on Indian scientists and practitioners of nano and stakeholder workshops organized by TERI in 2007–2010.

## 2. Public Engagement in the Context of India's S&T Policy

An analysis of the current state of public engagement in S&T in India needs to be rooted in a historical perspective and viewed in the context of the position enjoyed by science in the country. Three core policies, privileging science, have provided the course for S&T development since India's independence in 1947. The first Science Policy Resolution (1958) of the newly independent nation perceived science and technology as the “key to national prosperity,” intrinsic to bridging the gap with the “advanced” countries, and linked directly to India's constitutional mandate of achieving a welfare state. According to the Policy Resolution, “it is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of a recognition of this possibility that the idea of a welfare state has grown.” The kind of deification of S&T in the Indian policy establishment in this era is best illustrated by the famous statement of the first Prime Minister of independent India, Jawaharlal Nehru, who pronounced that dams and laboratories would be the temples of modern India. Nehruvian India was committed to a civic society of development, industrialization, and eventually the national security state—a world where science policy and the scientific perspective became as important as the national flag (Visvanathan 1998).

The second core policy, the Technology Policy Statement of 1983, emphasized technological self-reliance, technology transfer, and its indigenization to suit local contexts and to help solve India's “multifarious problems.” S&T is perceived as being integral to “building the India of our dreams.” The recent Science and Technology Policy of 2003 reiterates the commitment of the Indian state to “support S&T in all its facets” and recognizes its “central role in raising the quality of life of the people of the country, particularly of the disadvantaged sections of society, in creating wealth for all, in making India globally competitive, in utilizing natural resources in a sustainable manner, in protecting the environment and ensuring national security.”

Science and technology policy scholars in India, particularly those belonging to the “Science, Development and Violence” school like Visvanathan and Nandy, point out that this privileged position of S&T, and its perceived linkage with self-reliance, national security and so forth, has led to a state where it brooks no criticism and to dissent is perceived as being irrational (Rajan 2005). The Nehruvian era with its glorification

of dams and laboratories, and subsequently the “Emergency” period—the declaration of dictatorship by Indira Gandhi suspending civil rights during the 1970s, infamous for forced sterilizations in the name of science—contributed to a state of affairs when the “Indian pursuit of scientific knowledge became bureaucratic and science became a positivism” (Visvanathan 1998). While the post-independent Indian state had no space for dissent, the “father of the nation,” Mahatma Gandhi, had been one of the strongest dissenters of western science (Quartz 2010). According to Prasad (2001), Gandhi’s work can be understood as a critique of S&T, where not technology transfer but a collaborative effort between experts and civilians is central. Disenchantment with state policy, the violence associated with the Emergency period, and the forced displacement of local populations due to dams triggered the growth of dissenting social movements concerned with forestry—the Chipko movement; the anti-dam struggles—such as the Narmada Bachao Andolan; anti-nuclear protests; and a number of grassroots science movements during the 1970s and 1980s. It also led to the emergence of the Centre for the Study of Developing Societies—the Science, Development and Violence School (Rajan 2005)—as “a hub of dissenting intellectuals, journalists and civil rights activists” in the 1970s (Nandy 1996).

These alternative imaginations of S&T, best exemplified in Gandhi’s imagination of S&T as a collaborative effort between experts and civilians, is, however, yet to make a significant impression on the official state policy. According to Visvanathan (1998), the question of science in India boils down to “popularization, to science as consumption.” This objective of popularization of science is the motive of the Indian state for its public engagement with science and technology. A review of the S&T policies of 1958, 1983 and 2003 evidence a lack of “engagement” in favour of terminology such as public “education,” “awareness” and “communication.” The stated objective of S&T policy in the 2003 document is “to ensure that the message of science reaches every citizen of India, man and woman, young and old, so that we advance scientific temper, emerge as a progressive and enlightened society....” It promises support for wide dissemination of scientific knowledge, with the National Council for Science and Technology Communication being the designated agency to communicate S&T and stimulate scientific and technological “temper.” According to critics like Nandy (1988), this cultivation of “scientific temper” is a tacit way of ensuring continued political domination of a technocratic modern elite over the political decision-making process. This attitude has not changed much recently. A vision for the future of Indian science, drafted by the Indian National Science Academy in 2010, envisages “increased public engagement with science” as synonymous with a “concerted effort to communicate features of Indian science more effectively.” Upstream engagement remains unmentioned, an imperative recognized in most industrialized countries. Science and the framing of public policy are envisioned through “interaction of scientific community with administrators and law makers in the larger context of public engagement and societal support for science and scientific activity.” The former President of India, Dr. A.P.J. Abdul Kalam, one of India’s most respected scientists and missile technologists, perceives that the fundamental problem with science, which he describes as “very pure in its aims,” is the “division of people between those who know science and those who do not; those who use it and those who do not” (Kalam 2011). He envisages the role of science communication as concerned only with removing the imbalances in this knowledge divide and transferring “knowledge from the experts to the least empowered citizen without the concern of distance and time taken.” According to Kalam, science communication should aim to imbue citizens with excitement about science, to raise citizens’ aware-

ness to the advances of science and its contribution to society, and to motivate students to take up science as a profession (*ibid.*).

This leads one to assume that the deficit model dominates the Indian state's engagement with S&T. A recent editorial in the journal *Current Science* in March 2011 drew attention to the great need for scientists in the Indian policy establishment to engage meaningfully with the public on a range of contentious issues such as the safety of nuclear power, GMOs, climate change mitigation, ethical issues in health research, and implications of nanotechnology in the future. Narain (2011), in a scathing commentary on the attitude of scientists in the Indian policy establishment, laments that "the country's top scientists have withdrawn further into their comfort zones, their opinion frozen in contempt that Indian society is scientifically illiterate." Her gloomy prediction is that "in future there will be even less conversation between scientists and all of us in the public sphere." However, as observed by Visvanathan and Parmar (2002), since the 1990s a shift at least in "moral valency" is discernible from atomic energy to information technology (IT) and biotechnology. In their view, while atomic energy is a world not open to public scrutiny and democratic debate, IT "bubbled like something out of a Schumpeterian world," characterized by a "sense of civil society involvement" where the state was not the key policy maker and all its official heroes emerged from outside of the scientific establishment. Visvanathan and Parmar argue that biotechnology here falls somewhere in between atomic energy—which embodied the national security state—and IT, which represented a celebration of the market.

### 3. Emerging Technologies and S&T Policy in India

In India, active state support is offered to emerging technologies, with nanotechnology, biotechnology, information technology and, more recently, cognitive science being considered vital to India's future as the "four pillars of the 21<sup>st</sup> century" (Department of Science and Technology 2011). According to the National Biotechnology Development Strategy (2007) brought out by the Department of Biotechnology, for a country like India biotechnology is "a powerful enabling technology that can revolutionize agriculture, healthcare, industrial processing and environmental sustainability." Incidentally, civil society organisations (CSOs), such as Gene Campaign, allege that the public participation process preceding the development of this strategy was "a sham" and that no efforts were made to ensure a transparent and consultative decision-making (Sahai 2009).

The Department of Biotechnology is the primary promoter and funder of public sector agricultural biotechnology (GMOs) in India, and the government policy of "promotion" is being pursued through three interconnected "down-stream" policies:

- to build R&D capacity in a number of institutions spread over the country;
- to let the transfer of genetic modification (GM) technology from selected institutions and companies in North America and Western Europe determine the specific GM-routes taken by Indian researchers;
- to promote research collaborations between selected Indian and foreign public sector institutions (Indira et al. 2005).

Despite considerable research and development (R&D) being conducted in the public sector, ironically the only commercially grown GM crop—Bt Cotton—has been

developed by the private sector. In interview, a senior scientist at Punjab Agricultural University—who is engaged in research on GM crops including rice—suggested in 2008 that while research on developing GM crops suited to the Indian climatic conditions has taken place in government institutions all across the country, it has been multinational corporations (MNCs) with their vast resources who have dominated the scene so far. In his view, resource limitations and bureaucratic hurdles are the main reason for this failure of government institutions. He insists, however, that publicly funded research in agricultural biotechnology needs to flourish in order to break the monopoly of MNCs and ensure availability of low cost seeds to Indian farmers.

The government remains a strong promoter of agricultural biotechnology in India. India has in place an elaborate legal framework for regulating the risks arising out of technology development and to ensure biosafety. However, it has been suggested that the separate roles of technology promotion and regulation have become blurred, and that the regulatory function is being compromised owing to conflicts of interest, non-transparency and the lack of public accountability of government agency responsible for regulation (Sahai 2004). A former director of the Central Cotton Research Institute in Nagpur asserted in interview that the whole process for the approval of Bt Cotton for commercialization by the government in 2002 went “by the book.” He goes on to suggest, however, that although all formalities pertaining to field trials and regulatory requirements were adhered to, there was an unjustified expedition of the process, which he believes to be at the behest of MNCs, and a number of anomalies with the testing procedure.

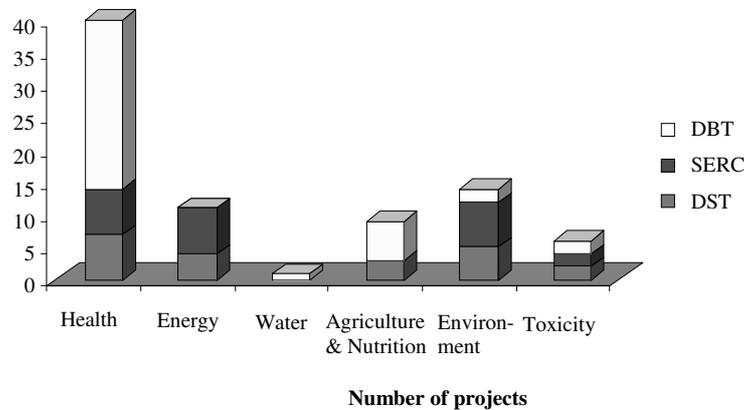
The trajectory of nanotechnology to a large extent is similar to that of agricultural biotechnology, in the sense that it has developed with active state promotion. It is currently being pursued under the Nanoscience and Technology Mission of the Department of Science and Technology, with a budget of Rupees 1000 *crores* for the period 2007–2012, with the key areas of emphasis being basic research promotion, infrastructure development, applications and human resource development (Nano Mission website, <http://nanomission.gov.in/> [accessed on December 11, 2010]). In the opinion of Dr. A.P.J. Abdul Kalam, one of the most influential patrons of nanotechnology in India, the country is looking to nanotechnology research, among other scientific endeavours, to help it achieve its goal of becoming a “developed” nation by 2020 (cited in *Nano Werk* 2008). A feeling also pervades in the Indian policy establishment that India “should not miss the bus” in nanotechnology and in the convergence of nanotechnology with biotechnology and information technology. Kalam (2006) in an address at the inauguration of the Indo-US Nanotechnology Conclave exhorts Indian scientists and industry to work together on commercially viable products for a global market to not miss out on an opportunity as happened before in the case of, for example, the micro electronic revolution and liquid crystal displays.

Unlike agricultural biotechnology, however, public sector R&D institutions have assumed the lead in nanotechnology research. Industry participation remains very limited. A look at Indian nano patents filed both abroad and at the Indian Patent Office indicates that the publicly funded Council of Scientific and Industrial Research (CSIR) and Indian Institutes of Technology are far ahead of industry in terms of numbers of patents filed and granted (Gupta 2009, Barpujari 2010).

Currently, India does not have a separate regulatory regime for nanotechnology and existing legislation will have to undergo considerable amendments in order to be applicable to nanomaterials and products (Barpujari et al. 2009). However, government is contemplating setting up a Nanotechnology Regulatory Board (*Livemint*, February

22, 2010). The policy establishment is yet to take into serious consideration the potential risks of the technology as is evident from the low priority accorded to risk research, which should precede regulation. A very small number of projects are being publicly funded to look into toxicity issues, and there is almost no engagement with the social sciences and humanities, as evidenced by the lack of government funding for such studies, as figure 1 suggests.

**Figure 1:** Sector-wise distribution of projects sponsored by DST (Department of Science and Technology), DBT (Department of Biotechnology) and SERC (Science and Engineering Research Council, 2006–2008).



Source: The Energy and Resources Institute (2010)

#### 4. Public Engagement in Emerging Technologies in India: The Story so Far

It is against this backdrop of active government support and a “positivist” pursuit of official S&T that both agricultural biotechnology and nanotechnology have grown in India. In this section, Indian initiatives for securing public participation in agricultural biotechnology and nanotechnology will be critically reviewed.

##### 4.1. Agricultural Biotechnology

In the case of agricultural biotechnology, public engagement activities have largely taken the shape of capacity building or public outreach as an important component of the official strategy to “promote” the technology. Such activities occupy pride of place in the United Nations Environmental Programme (UNEP) Global Environmental Facility’s Biosafety Framework—implemented by the World Bank through the Ministry of Environment and Forests. Apart from a series of workshops and consultations at the national level, there has been considerable emphasis on generating awareness at the state and district levels in India. For instance, during the period 2006–2008 about 80 “awareness” workshops were conducted at state and district levels in the nine Bt cotton growing states of India to “create widespread awareness about science, status and rules and regulations governing GM crops among field level officials, scientists and progressive farmers for effective post-release monitoring of Bt cotton.” The workshops were also expected “to provide a forum for interaction and feedback regarding the perfor-

mance of Bt cotton so as to clarify various issues among different stakeholders” (Biotech Consortium India Ltd. 2008). The Government has also established the Indian GMO Research Information System (IGMORIS), which is a database on activities involving the use of GMOs and subsequent products in India. The primary purpose of this website is to “make available objective and realistic scientific information relating to GMOs and products thereof under research and commercial use to all stakeholders including scientists, regulators, industry and the public in general.”

A significant gap in the public communication strategy adopted in this context is the failure to reach farmers, with the result that farmers growing Bt Cotton in most instances fail to adhere to the prescribed restrictions. This became evident in FGDs conducted by the author with farmers growing Bt cotton in Wardha and Yavatmal districts of Maharashtra state and in Ludhiana in the state of Punjab in 2008. Farmers in both the states expressed their ignorance about the need to maintain a “mandated refuge” while growing Bt cotton. At the same time, they also admitted that open grazing of livestock on the cotton fields (both Bt and non-Bt), after the cotton is harvested and before the stalks are removed, is a common practice. A former scientist from the Central Institute of Cotton Research in Nagpur, in interview in August 2008, expressed the opinion that this “mishandling” of a new technology was due in large measure to the “corporate” nature of the technology, where seed dealers promoting proprietary seeds are the main source of information to the farmer on best practices. According to him, an earlier technological intervention in Indian agriculture—the Green Revolution—was basically ushered in by the public institutions and the extension agencies of the state, which played a very important role in providing technical advice to the farmers. The context of cotton production in India has, however, undergone remarkable changes with the introduction of genetically engineered cottonseed, which is a proprietary product of private seed companies. In his view, the greatest regret lies in the fact that the vast network of agricultural extension in the country has not been harnessed to dispel doubts and encourage safe practices among farmers taking up the cultivation of Bt cotton. During FGDs with farmers in Assam, where no GM crops are cultivated, focus group participants expressed ignorance about GMOs. When attempts were made to explain the scientific principle to them, they refused to believe that a crop like that could even exist. Instead the farmers asked the author: “are you mad to think of something like it?”

A look at the proceedings of the numerous capacity building workshops conducted by the government (available at the government website on GMOs <http://igmoris.nic.in/CapacityBuilding.asp>) suggests that national, regional, or state level consultations have focused on a very select group of stakeholders—officials, scientists, regulators, media representatives and a few “progressive farmers”—but have largely ignored the ordinary publics—the consumer, the housewife, the student and others. It is not very surprising that awareness levels about GMOs among urban publics is quite low as attested to by the few studies available. A survey conducted by the Indian Institute of Management in Ahmedabad—with 602 respondents in the city of Ahmedabad and 110 respondents online—indicates that more than 90% of the respondents were not aware of GM crops (Deodhar et al. 2007). Another study, by Sahai and Haribabu (2010), in five states of India found that the level of awareness about GM foods was very low and confused among urban consumers. The study found that urban consumers were unclear about what GM foods were, and about the status of GM foods in India with respect to availability, labeling or risks and benefits. Interviews and FGDs conducted by the author in 2008 in the cities of Ludhiana (Punjab), Nagpur (Maharashtra) and Guwahati (Assam) produced very similar findings. For instance, there is a ten-

dency for many educated urban consumers to confuse GMOs with hybrids. A retired central government employee residing in Nagpur said: "I do not know much about the science behind it, but I can tell you in brief what it is. The tomato we are getting today is genetically modified. Earlier, we used to get small tomatoes, but now we get GM tomatoes, which are much bigger in size and look good, but do not taste as good." Similarly, an FGD with about 20 postgraduate students in Gauhati University suggests that while most have heard about GMOs, they think that the vegetables grown by farmers in Assam are mostly genetically modified (which is a wrong perception). An urban housewife of Ludhiana opines that biotechnology involves putting "something artificial in vegetables like the pumpkin to make them grow big. They do the same with melons." While the science behind GMOs was explained, many urban consumers expressed reservations about eating such food. A college student of Nagpur expressed strong reservations about eating "any GM food which has non-veg genes in it (from insects and animals). My mother is very strict about it; she will not allow such food into our kitchen, as it will make our kitchen impure."

#### *4.2. Nanotechnology*

With respect to nanotechnology, state initiatives to foster public engagement are relatively new and focused on creating awareness, and to "popularize" NT. The National Council for Science and Technology Communication (NCSTC), the government agency dedicated to communicating S&T, has been engaged in efforts to educate the public in NT using innovative and interesting communication tools like "nanosciencetoons" using cartoon depictions and humour to convey precise, de-mystified knowledge to the "layman" (Patairiya 2008). In all likelihood, this "layman" targeted by the NCSTC would be educated, in order to be able to comprehend the sciencetoons. It is still very early days to gauge the success of these initiatives.

So far, public engagement and debates in nanotechnology have remained mostly confined to the "knowledgeable" public or "experts." No formal debates have, however, been organized by the government. Stakeholder consultations held by the Energy and Resources Institute (TERI), from 2007 to 2010, have also focused on experts from the scientific policy establishment, social scientists, lawyers, CSOs, and others (reports of the stakeholder workshops on <http://www.teriin.org/ResUpdate/nano.php>). Even the limited surveys and studies available today have focused only on practitioners. Patra et.al (2010) in a study of perceptions of nanoethics among 58 Indian practitioners working in the area of nanoscience and nanotechnology indicate that 95% of those recognized ethical issues in this research area, and 60% could offer specific examples, which included possible ill effects on environment and human, use as a weapon, hype, professional ethics, laboratory testing on animals, cyborgs, widening the gap between rich and poor, self-replication, and longevity of human life. A TERI survey by Sahoo and Deshpande Sarma (2010) on risk perceptions among thirty scientists working in public funded scientific institutions/ laboratories indicate that Indian scientists are not very much perturbed by the risks of nanotechnology, and few take special precautions while working with nanomaterials, while very few are interested in taking up risk research.

## 5. Upstream Public Engagement in the Near Future?

From the discussion in section 4, it emerges that public engagement activities in both agricultural biotechnology and nanotechnology in India have been largely pursued applying the deficit model. Only some show resemblance to a limited dialogue model where attempts were made to engage with other “knowledgeable” publics or stakeholders. But even in the case of the latter, it can be assumed that the dialogue process was impeded by the positivist culture of S&T in India and the tendency of experts to take a non-critical stance on emerging technologies. The TERI survey of scientists working in the Indian scientific establishment who are unwilling to consider the potential risks of nanotechnology and the very limited government focus on risk research tell their own stories. Given this background, upstream public engagement appears to be an uphill task in India, made more difficult by the fact that engaging with the public, except for the purpose of cultivating “scientific temper,” has never received any policy focus (see section 2). One also cannot deny the difficulties involved in engaging the Indian publics, so varied in social backgrounds, and access to education, and the social and material goods to lead a life of dignity. To take a hypothetical example, it would logistically be very difficult to have a meaningful dialogue on a common issue even in a tiny village—women will be hesitant to discuss in front of men, members of a higher caste might refuse to sit with someone from a lower caste, an old illiterate person might hesitate to speak his mind owing to his lack of education, the desperate farmer might be willing to accept any technology promising even a minor increase in yield irrespective of the risk. In such a context there can be no substitute for effective science communication (targeted at different publics) of new technologies. Government agencies with their wide networks and influence will have to play an important role in disseminating the correct information among all sections of the society. Interestingly, the study on Public Knowledge, Attitudes, and Perceptions towards GMOs have come out with the surprising results, quite contrary to the trust deficit issues in developed countries, that Indians, both in the urban and rural areas, deposit more trust in the government and its scientists than in non-governmental organizations and MNCs for reliable information and to protect their interests (Sahai and Haribabu, 2010).

Despite the impediments, hope lies in the fact that in the recent past, owing to the initiatives of a proactive civil society, there has been an opening up of the agricultural biotechnology sector to public debate and discussion, with the voicing of public concerns which have had an impact on governmental policy decisions, as in the Bt Brinjal moratorium of 2010. In India, a large number of CSOs have been involved in the field of agricultural biotechnology and biosafety since the late 1990s (prior to the approval for commercial release of Bt Cotton in 2002), pushing for transparency and accountability in the regulatory system, incorporating the public interest and greater common good in policy decisions and for more effective public participation in decision-making (Indira et.al 2005, Barpujari 2007). The range of their actions have included engaging parliamentarians, submissions to ministries, inputs to policy, membership of Committees, legal action as well as street demonstrations, militant physical action like burning GM crops on trial plots. In fact, Indian non-governmental organisations have resorted to legal action, making the case, among other things, for increased public participation in the decision-making as an important international commitment under the Biosafety Protocol to which India is party (Gene Campaign v. Union of India, writ petition (civil) No. 115 of 2004 in the Supreme Court). Article 23 of the Protocol requires Parties to promote and facilitate public awareness, education and participation with regard to

biosafety, and also requires mandatory public consultation and disclosure of results of decisions back to the public in the decision-making process. Civil society engagement and their pursuit of the need for transparency using legal tools such as the Right to Information Act and public interest litigation have paved the way for a more transparent regulatory system in India. Companies are now forced to make public data on allergenicity and toxicity in the public interest, which earlier they sought to protect as confidential business information (Barpujari 2007).

In fact, it would not be wrong to say that it is this civil society engagement, and the controversies, which have contributed to paving in small measure the road for more upstream public participation in decision-making and the accommodation of dissenting voices, as seen in the Bt Brinjal case. Without seeking to probe into the legal basis (which remains tenuous), the decision of the government to impose a moratorium on the commercial release of Bt Brinjal in February 2010, in the wake of a number of public hearings conducted across the length and breadth of the country, can be hailed as the first tentative step towards upstream public engagement in emerging technologies. According to Chowdhury and Srivastava (2010), this almost referendum-like process of public consultation establishes certain important parameters. First, decisions involving large-scale utilization of technologies that bear an environmental and/or public health risk, should not only be based on scientific risk assessment but should also undergo a process of public engagement (stakeholder consultation) in order to gauge the social acceptance of that technology. Second, the scientific assessment report of expert committees on such technologies should be made public and comments invited on the report prior to a decision being taken.

In the case of nanotechnology, as of now, there has been limited participation of the different publics. It is also unlikely in the present scenario that it could give rise to the heightened controversy as seen in the case of agricultural technology. A number of reasons may be attributed to this. One is the fact that nanotechnology still remains a subject matter on which there is inadequate knowledge, and it is unlikely to have the same mass appeal of GMOs in which farmers and farmers' organizations, CSOs and ordinary consumers have shown strong interest. However, more upstream engagement can be expected to take place in the near future with the initiative of CSOs like TERI to create a meaningful dialogue among stakeholders, to contribute to a multilevel governance framework and for a responsive policy framework. The report of the TERI stakeholder workshop on Issues of Risk in the Regulation of Nanotechnology (2010) indicates that slowly but steadily stakeholders are discussing and debating the pros and cons of a soft versus hard approach to regulation, incremental or stand alone legislation, approaches to deal with environment, health and safety concerns as well as social and ethical concerns. However, it is still too early to predict how public engagement and debates on nanotechnology are likely to unfold in India in the near future given the active promotion of nanotechnology by the state for meeting developmental goals; the low priority accorded to the question of risk and accommodation of dissent; limited numbers of engaged CSOs (contrary to agricultural biotechnology); and also the fact that we do not have as yet much insight into perceptions of the publics on nanotechnology. Finally, there remains the question of the desirability of applying an upstream engagement model developed in the Western world in a very different context-historically, socially, politically and economically. According to Leach, Scoones and Wynne (2005), an uncritical enthusiasm and application of deliberative techniques to S&T issues in both the North and the South could have a "disciplining and thus participation-closing role" owing to the tacit prior framing of the modes and scope of such participatory ini-

tiatives and presumptive normative models of the “citizen.” Cooke and Kothari (2001) caution that participation could easily degenerate into a “new tyranny” when “participatory processes undertaken ritualistically turn out to be manipulative, counter-intuitive and contrary to its rhetoric of empowerment.” The question eludes straight-forward solutions, with the different publics in India needing to carefully consider “what conditions and what avenues of participation offers routes to more vital forms of dissent, to genuine negotiation and to political and practical solutions based on mutual recognition and respect” (Scoones, Leach and Cockburn 2006).

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